Chapter 7
REGIONAL WATERSHED MANAGEMENT

This chapter brings together the same goals, issues, and strategies discussed by area of responsibility in **Chapter 3** through **Chapter 6** into a geographically integrated format. The goals, issues, and strategies to resolve the issues are discussed for each watershed region. The District is divided into four watershed regions: the Lower East Coast, the Lower West Coast, the Upper East Coast, and the Kissimmee Basin. The District's planning regions are generally defined by the drainage divides of major surface water systems in South Florida. **Figure 31** shows the four watershed regions and the nine major watersheds that comprise the more than 100 drainage basins and subbasins of the District.

There is a significant connectivity and overlap among the major watersheds, reflecting both the historic flows of the Kissimmee-Lake Okeechobee-Everglades system and the impact of the Central and Southern Florida (C&SF) Project on the hydrology of South Florida. The movement of water throughout South Florida watersheds was significantly altered by the construction of the C&SF Project. Initially designed about fifty years ago, it has been reexamined in the C&SF Project Comprehensive Review Study (Restudy). The recommendations made in the Restudy will be implemented within the Comprehensive Everglades Restoration Plan (CERP) during the next 20 to 30 years and will affect virtually every watershed within the District. **Chapter 1** contains a more extensive description of the CERP. Several public works construction projects are identified for each of the regions, and **Figure 19** in **Chapter 1** shows their locations.

LOWER EAST COAST REGIONAL WATERSHED

The Lower East Coast (LEC) regional watershed encompasses a rapidly expanding, developed area of about five million residents with most of the population living along the coast. It contains extensive agricultural lands, including the Everglades Agricultural Area (EAA); extensive wetlands comprising the Everglades system; and important estuaries, such as the Florida and Biscayne bays. Four major watersheds are completely within the LEC region: the LEC urban area, Biscayne Bay, Everglades-Florida Bay, and the Florida Keys. Part of the Okeechobee Basin is also within the LEC region, but with the exception of Lake Okeechobee issues, the Okeechobee Basin is discussed in the **Kissimmee Basin Regional Watershed** section. Lake Okeechobee is discussed in the **Lower East Coast Regional Watershed** section because it is a major source of water for the LEC region and its health affects the health of the Everglades-Florida Bay watershed. Due to the complexity of the water management issues for the LEC, the areas of responsibility are summarized for the region as a whole and discussed in detail by major watershed. The Biscayne aquifer is also discussed separately within this section.

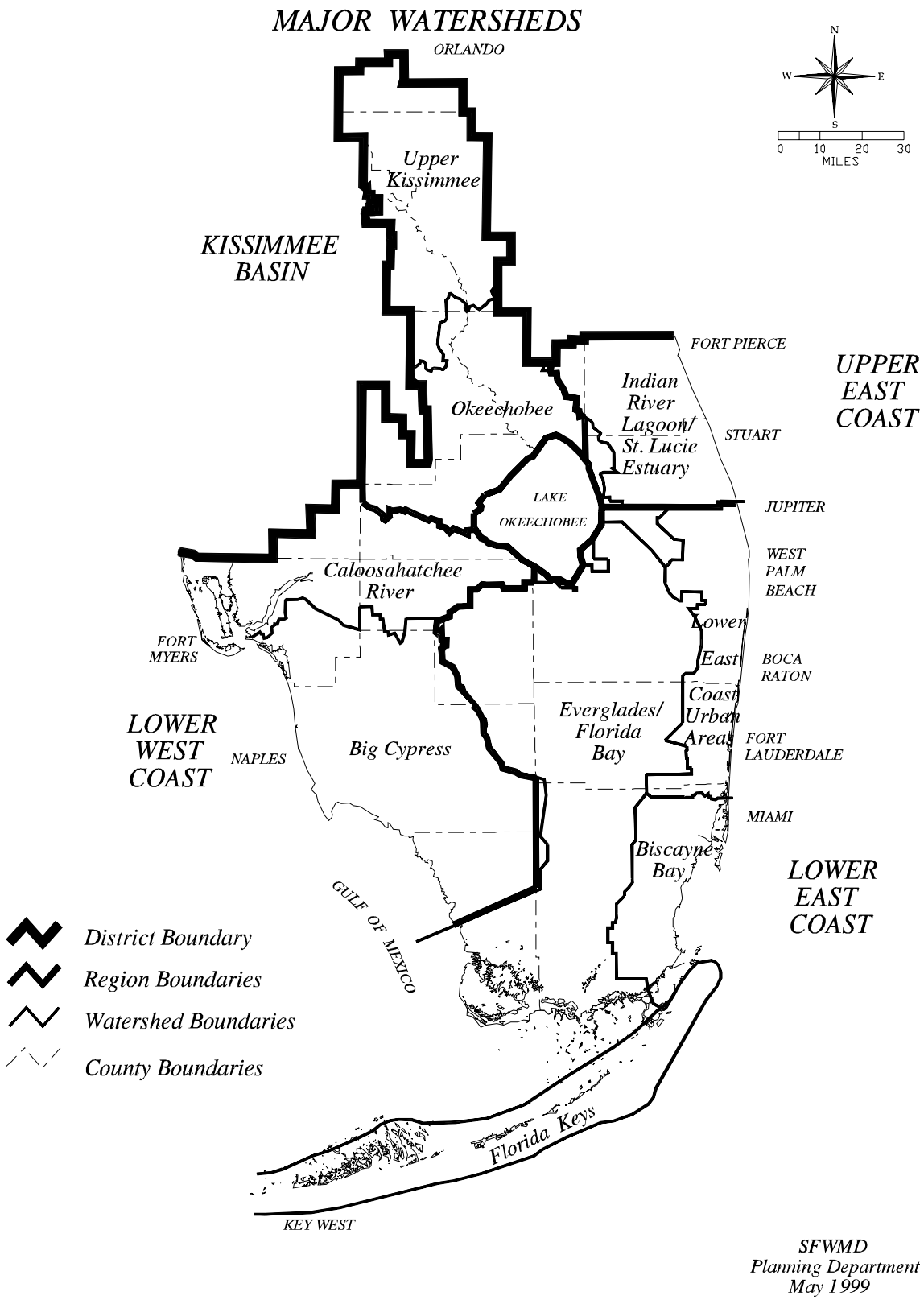

Figure 31. The Four Watershed Regions and the Nine Major Watersheds of the SFWMD.

Overall Lower East Coast Regional Watershed

Regional Watershed Goals

The regional watershed goals for the LEC region are as follows:

- Assure the availability of an adequate supply of water for all competing uses deemed reasonable and beneficial
- Maintain the functions of natural systems
- Maintain the overall present level of surface and ground water quality
- Improve and restore the quality of waters not presently meeting water quality standards
- Maintain current flood protection

Status of Areas of Responsibility

The four areas of responsibility are water supply, flood protection and floodplain management, water quality, and natural systems. A summary of the status of the areas of responsibility within the LEC region is provided here and a more detailed description is provided within the major watershed basin discussions.

Water Supply

The primary sources for water supply in the LEC region are the Biscayne aquifer, Lake Okeechobee, and the Water Conservation Areas (WCAs). Most water used in the urbanized coastal basins is withdrawn from the Biscayne or other surficial aquifers, which are recharged primarily from local rainfall. Other important sources of recharge are seepage from the WCAs and deliveries of surface water from the WCAs and Lake Okeechobee.

Competition for water among urban development, agriculture, and natural systems is extensive. The LEC region has access to alternative water supply sources, although there has been no significant use of these alternatives to date. These water supply alternatives include reverse osmosis treatment of water from the Floridan aquifer, Aquifer Storage and Recovery (ASR), surface water storage, reuse, and backpumping of storm water. Alteration of demand patterns, through increased conservation measures, can also aid in reducing water supply needs within the LEC region.

Flood Protection and Floodplain Management

Most of the C&SF Project lies within the LEC region. The C&SF Project was designed in 1947 to provide flood protection based on future land uses projected at that time. Areas projected to be developed with urban land uses were afforded higher levels of flood protection than those anticipated to be used for agriculture or to remain undeveloped. As South Florida developed, urban land uses have spread further west than

was anticipated in the original system design. In general, the western subbasins are more prone to flooding because of low ground surface elevations relative to the eastern subbasins. Development in these areas must depend on on-site storage and local storm water management systems for their flood protection.

Water Quality

Water quality issues within the LEC region include the deterioration of water quality in Lake Okeechobee, adverse impacts of large water releases into the St. Lucie and Caloosahatchee estuaries, aquatic weed invasion in the canals of the LEC urban area, pollution of the Miami River and its subsequent effect on Biscayne Bay, degradation of natural systems within the Everglades and Florida Bay, impacts to the coral reefs and other natural resources of the Florida Keys, and saltwater intrusion into wellfields along the coast.

Natural Systems

Natural systems within the LEC region have been impacted by the construction of the C&SF Project, invasion of exotic plants, urban and agricultural development, and water quality deterioration. Significant environmental resources within the LEC region are described under the resources section of each major watershed basin.

Lake Okeechobee

Background

Lake Okeechobee is the largest lake in Florida and the third largest lake entirely within the United States. Its watershed encompasses the Lower Kissimmee Basin. Historically, the lake was an integral part of a naturally integrated hydrologic system stretching from the headwaters of the Kissimmee River to Florida Bay. During the wet season, water along Lake Okeechobee's southern shore would intermittently spill over into the upper Everglades with sheetflow continuing south to Florida Bay.

Construction of the Herbert Hoover Dike stopped the sheetflow and altered Lake Okeechobee's natural morphometry and hydrology. The dike is an earthen dam which enclosed all of the lake's historic limnetic zone, but only a small portion of its historic littoral zone. The largest portion of the original littoral zone is now located outside of the dam and isolated from the lake. Vegetative changes continue to occur in both littoral zone fragments.

Resources

Lake Okeechobee is of regional significance because of its enormous water holding capacity and water supply capability. During water shortages, canal discharges from Lake Okeechobee provide recharge water for the Biscayne aquifer, indirectly

supplying water to 90 percent of the LEC region's five million residents. The lake also supplies irrigation water for sugarcane, vegetables, sod, and rice crops grown in the EAA.

Lake Okeechobee and its associated wetlands provide habitat for a number of plants and animals, including several rare and endangered species such as the wood stork, snail kite, West Indian manatee, and Okeechobee gourd. Migratory birds and waterfowl use the littoral zone and adjacent wetlands as a resting area along the Atlantic flyway.

Lake Okeechobee is a major recreational resource. The lake supports a nationally renowned sport fishery for largemouth bass and black crappie and is an important winter waterfowl hunting area. It is also part of the navigable Okeechobee Waterway connecting the east and west coasts of the state.

Specific Lake Okeechobee Goals

The Lake Okeechobee goals are as follows:

- Protect and enhance ecosystem health
- Ensure adequate local and regional flood protection
- Ensure an adequate local and regional water supply
- Support and improve recreational opportunities on and around Lake Okeechobee
- Maintain navigation on and around Lake Okeechobee
- Protect and enhance Lake Okeechobee's aesthetic characteristics

Status of Areas of Responsibility

Water Supply

Within its service area, Lake Okeechobee is the primary source of water used to supplement local rainfall. Lake Okeechobee depends on rainfall runoff from its numerous tributary basins, the largest of which is the Kissimmee Basin. However, use of the lake for water supply has impacted its natural systems, especially its littoral zone.

Water Quality

Lake Okeechobee's water quality has deteriorated since the 1960s, primarily because of phosphorus and other nutrients entering the lake from tributaries to the north. Large algal blooms in the 1970s and 1980s suggested that Lake Okeechobee was receiving excessive nutrients and becoming increasingly eutrophic. Both phosphorus and nitrogen contribute to algal growth, but bacteria and blue-green algae can fix nitrogen from the atmosphere and add it to the water column, making it harder to control than phosphorus. Accordingly, the primary water quality issue associated with the lake is the control of phosphorus. Another source of nutrients entering the lake has been backpumping of runoff from sugarcane and other crops in the EAA. The SFWMD has sought to reduce this source

of nutrient loading to the lake through implementation of its Works of the District Rule (Chapter 40E-61, F.A.C.), which requires permits for the discharge of runoff into SFWMD owned, operated, maintained, or regulated waterways. To address these issues a Surface Water Improvement and Management (SWIM) Plan has been completed (SFWMD, 1997b) and is currently being implemented for Lake Okeechobee.

Lake Okeechobee Issues

The major issues affecting Lake Okeechobee are water quality and littoral zone protection and exotic plant infestation.

Lake Okeechobee Water Quality and Littoral Zone Protection

Issues regarding Lake Okeechobee water quality and littoral zone protection include phosphorus loading from the watershed, coupled with in-lake sediments acting as a nutrient sink, and high water levels impacting littoral communities

Phosphorus Loading. Increased phosphorus loading to Lake Okeechobee was the key water quality issue identified in the *Interim Lake Okeechobee SWIM Plan* (SFWMD, 1989). Between 1974 and 1989 lakewide concentrations of phosphorus increased by two and one-half times. Algal blooms suggested that the lake was receiving excessive nutrients. Subsequent modeling indicated that lake loading needed to be reduced to an annual average of 397 tons, some 200 tons below the loading at that time. During 1998, phosphorus loadings to Lake Okeechobee were the highest since 1984, despite a rigorous and expensive cleanup program involving the cooperation of dairy and other farmers north of the lake. Much of these loadings appeared to be attributable to the S-65D, S-65E, S-154, and the Taylor Creek/Nubbin Slough watersheds.

In 1997, the *Lake Okeechobee SWIM Plan* (SFWMD, 1997b) was updated to include management objectives and strategies for water supply, environmental resources, flood protection, recreation and navigation, as well as to update information in the water quality and public information elements. To reduce phosphorus loading to the lake the District has developed several strategies, including continued implementation of the *Lake Okeechobee SWIM Plan* (SFWMD, 1997b) and updating the plan by 2000; completion of the Lake Okeechobee Water Retention/Phosphorus Removal Critical Project by 2002; carrying out the Lake Okeechobee tributary sediment dredging by 2005; continuation of the Lake Okeechobee Works of the District Permitting Program; and continuation of research and data collection efforts. The Florida Department of Environmental Protection (FDEP), in conjunction with the District, is in the process of developing a Total Maximum Daily Load (TMDL) for phosphorus for Lake Okeechobee.

High Water Levels. Water levels in Lake Okeechobee have been much higher than average during the past five years (1994-1999), affecting the health of the lake. Mud sediments have moved from the middle of the lake to areas near the shore, making the water turbid. This has caused less light to reach the lake bottom, resulting in the loss of some aquatic plants. Wave action has uprooted vast areas of submerged plants, causing them to lose their ability to stabilize the sediments and provide an important habitat for

fisheries. This vegetation has been naturally deposited along the shore of the lake, forming a muck berm in areas and impacting bulrush, Kissimmee grass, and eelgrass communities which provide fish habitat. To help address this issue, the District is currently establishing Minimum Flows and Levels (MFLs) for Lake Okeechobee.

Other Water Quality Issues. Other water quality issues include the need to more thoroughly evaluate other water quality parameters relative to existing Class I, Class III, and Class IV standards for the basin and to obtain a better understanding of the impacts of nitrogen upon the lake ecosystem. The *Interim Lake Okeechobee SWIM Plan* (SFWMD, 1989) also recognized the need to ascertain the impacts of septic tank systems upon lake water quality.

Exotics Infestation

Lake Okeechobee has been infested by exotic species that are threatening the natural ecosystem of the lake. In the marsh zone of Lake Okeechobee, at least 14 exotic plant species have been documented. Of those, five species have become a major threat to the ecosystem due to their rapid expansion into areas once occupied by native plants. Melaleuca and torpedo grass are threatening the higher elevation regions and water hyacinth, water lettuce, and hydrilla are threatening the lower elevation areas where there is year-round standing water. The elimination of melaleuca from around the lake is continuing, and the SFWMD is currently continuing research on the possibility of eradicating the exotic plants in the littoral zone.

Lower East Coast Urban Area

Background

The LEC urban area watershed consists of the coastal ridge portions of Palm Beach and Broward counties lying east of the WCAs and is part of the most densely populated part of the state. Except for pockets of publicly protected preservation lands, the coastal region from West Palm Beach southward through Hollywood is almost completely urbanized. The largest population centers are near the coast and include the cities of West Palm Beach, Fort Lauderdale, and Hollywood.

Significant natural system resources within the LEC urban area watershed include the West Palm Beach Water Catchment Area, the Lake Worth Lagoon, the Loxahatchee River and Slough, and the Strazzulla Tract.

Specific Watershed Goals

The LEC urban area watershed goals are as follows:

- Assure the availability of an adequate supply of water for all competing uses deemed reasonable and beneficial
- Maintain the functions of natural systems

- Maintain the overall present level of service for flood protection
- Maintain ground water quality
- Improve and restore the quality of waters not presently meeting water quality standards

Status of Areas of Responsibility

Water Quality

Water quality in the LEC urban area is fair. The major source of contamination is urban storm water. The canals in the Fort Lauderdale area, especially the New River, generally exhibit the poorest quality. Aquatic weeds frequently choke these canals and must be removed by mechanical harvesting or herbicide treatment.

Low water levels in the canals east of the control structures enable salt water to migrate into the ground water, wellfields, and natural freshwater systems upon which the urban areas depend for a potable water supply. Therefore, water levels in coastal canals are controlled near the coastal shoreline to help prevent this overdrainage and to resist saltwater intrusion.

Natural Systems

The Lake Worth Lagoon, a coastal waterway in central Palm Beach County, is subjected to extreme salinity changes due to changes in the volume, distribution, and timing of freshwater inflows. The loss of wetlands, lowered water tables, increased watershed imperviousness, and the redirection of historical runoff have significantly reduced discharges to the lagoon during drought conditions, and increased discharges during wet conditions.

Issues

The major issues affecting the LEC Urban Area are future water supply and source protection, and Lake Worth Lagoon protection.

LEC Urban Area Future Water Supply and Source Protection

It is anticipated that between 1995 and 2020, population in the LEC region will increase by 35 percent, irrigated acreage will decrease by 11 percent, and the overall water demand will increase by about 16 percent (SFWMD, 1998b). Palm Beach County is projected to increase its Public Water Supply (PWS) demands by almost 58 percent (SFWMD, 1998b). With current water supply capabilities, urban area water shortages will increase in frequency and severity.

Because the Biscayne aquifer lies close to the surface and is highly permeable, ground water in the LEC region is vulnerable to contamination. Rapid urbanization continues to threaten contamination of the shallow ground water supplies. For example,

costly contamination has already occurred at the Peele Dixie wellfield in Fort Lauderdale. Fortunately, because of the natural benefits of seasonal heavy rainfall combined with dilution, levels of contamination within the Biscayne aquifer are generally reduced in magnitude.

Several programs have already been implemented to ensure future urban and agricultural water supply and source protection:

- Wellfield protection programs have been designed to protect existing supply sources and are being implemented in Broward and Palm Beach counties.
- A Floridan aquifer model is being developed based on Floridan aquifer well drilling and will be implemented by 2000.
- The *Lower East Coast Regional Water Supply Plan* (SFWMD, 2000b) was completed in 2000 and is currently being implemented.
- To facilitate conservation, the *Lower East Coast Regional Water Supply Plan* (SFWMD, 2000b) recommends the establishment of a water conservation coordinator. This plan also recommends that future rulemaking establish enhanced water conservation requirements for water users. Potential alternative water supply sources within the LEC include the construction of reservoirs, desalination of water from the Floridan aquifer, and the utilization of ASR. The plan recommends regional ASR projects in Palm Beach, Broward, Glades, and Okeechobee counties, as well as utility ASR projects in Miami-Dade and Palm Beach counties. It also calls for the construction of regional reservoirs in concert with ASR projects. It directs that the feasibility of desalination of water from the Floridan Aquifer System should be further evaluated using refinements of the existing Floridan Aquifer System ground water flow model.
- Subregional plans are also being developed: the Northern Palm Beach County Comprehensive Water Management Plan, the Southeast Palm Beach County Integrated Water Resource Strategy, and the Eastern Broward County Integrated Water Resource Strategy.
- The Hillsboro ASR and the In-Ground Reservoir Technology pilot projects will help determine if ASR will enhance storm water storage for future use. Construction of the Western Hillsboro (Site 1) ASR Pilot Project is scheduled for completion by 2003. The In-Ground Reservoir Technology Pilot Program is scheduled to be carried out by 2012 and the completion of the Southern L-8 In-Ground Reservoir General Evaluation Report is scheduled for completion by 2014.
- The Broward County Secondary Canal System will provide recharge to the ground water and wellfields and stabilize the saltwater interface in southeastern and southern coastal Broward County by pumping any excess water within the basin into the coastal canal systems to maintain canal stages. The system is scheduled for completion by 2009.

- Large portions of the Loxahatchee Slough, located in northern Palm Beach County, have been acquired through the District's Save Our Rivers (SOR) Program.

Lake Worth Lagoon Protection

The Lake Worth Lagoon is connected to the Atlantic Ocean by two permanent inlets: a northern inlet 800 feet wide by 35 feet deep and a southern inlet 130 feet wide by up to 12 feet deep. The lagoon contains 28 marinas and hundreds of private docks along its shoreline. Since settlers first arrived on the banks of Lake Worth in the 1800s, the lagoon has experienced a continuous onslaught of channel dredging, shoreline hardening, dredging and filling, causeway and bridge construction, dock and marina construction, canal development, industrial and sewage waste disposal, storm water runoff, port development, mosquito control, and power plant construction and operation.

Today, the lagoon is subjected to extreme salinity changes due to changes in the volume, distribution, and timing of freshwater inflows. The loss of wetlands, lowered water tables, increased watershed imperviousness, and the redirection of historical runoff have significantly reduced discharges to the lagoon during drought conditions and increased discharges during wet conditions.

Efforts have been under way since 1994 to reverse these conditions. By August 1998, an interagency team had developed a management plan to guide the restoration and enhancement of the Lake Worth Lagoon. The District has been cooperating with Palm Beach County on this effort and has developed a hydrodynamic salinity model for the lagoon. The lagoon restoration is scheduled to be completed by 2011.

Biscayne Bay

Background

The Biscayne Bay watershed includes both the highly urbanized coastal area of Miami-Dade County and 83,000 acres of agricultural lands to the southwest. Vegetables, tropical fruit, and nursery plants are grown within this agricultural area.

Biscayne Bay is a shallow, subtropical estuary with a natural depth ranging from three to nine feet. Much of the upper bay has been modified and dredged, so that depths now average six to ten feet and include some dredged areas and channels up to forty feet deep. A basin of about 840 square miles drains to the bay. Seventeen canals in eastern Miami-Dade County operated by the District provide most of the surface flows of fresh water into the bay.

The significance of ground water flows to Biscayne Bay is uncertain. Existing data suggest that historic dry season ground water flows have been greatly reduced. Before canals and structures existed, some surface water flowed to the bay through the Miami River and a few natural creeks and streams. During wet periods, large amounts of water

entered the bay as surface water flowed across adjacent freshwater marshes. Canal construction has accelerated the rate at which ground water levels recede at the end of the wet season, because surface water now discharges from the canals at a much faster rate rate than under natural conditions.

Resources

Biscayne Bay continues to support a wide variety of plants and animals, some of which are important for fisheries. Many rare, threatened, and endangered species occur in or near the bay, including manatees and crocodiles. Significant natural system resources within the Biscayne Bay watershed include Biscayne National Park, Southern Glades, the Frog Pond and the Model Lands Basin.

Specific Watershed Goal

The goal for Biscayne Bay is to maintain and improve water quality to protect and restore natural ecosystems and human uses of the bay while protecting its environmental resources.

Status of Areas of Responsibility

Water Quality

Water quality within Biscayne Bay is generally good, with a few exceptions. Monitoring data has indicated that some areas have low oxygen levels or have been contaminated by sewage and other pollutants. Oxygen levels are moderate in the bay, and the tributary canals have even lower levels. The Miami River, a tributary to the bay, has serious problems with high coliform counts and contaminated sediments. Overloading of the sewer system during periods of high inflow of storm water or ground water results in discharges of sewage to the river. Sediments are contaminated with heavy metals, pesticides, and organic pollutants. Sources of these pollutants include storm water runoff, domestic and industrial waste discharges, and bioacid used on vessels. To address these issues a SWIM Plan has been completed and is currently being implemented for Biscayne Bay.

Natural Systems

The Biscayne Bay watershed includes coastal upland, coastal wetland, and submerged aquatic communities. These communities provide shoreline stabilization, nutrient cycling, removal of suspended materials, habitat for aquatic and terrestrial organisms, and a basis for the aquatic food chain. These communities require good water quality, adequate light penetration, and inputs from healthy upland systems to maintain their integrity. They are impacted by water quality and physical disturbance, including land development and dredge and fill activities. In the southern portion of the bay, some mangrove productivity has been lost because sheetflow of fresh water has been redirected as a result of the drainage projects serving South Florida. Prior to the construction of the coastal canal system, marshes along the shore of Biscayne Bay were dominated by

freshwater plants. Many of these areas have been invaded by saltwater marsh species and mangroves. Seagrass beds are found throughout the bay, but are more prevalent in South Bay than North Bay. In South Bay, the seagrass beds benefit from flushing action and the lack of urbanization of adjacent land areas.

Card Sound and Barnes Sound are sensitive marine lagoons in the southernmost portion of the bay. They serve as important habitats for a number of threatened and endangered species. Card Sound and Barnes Sound are areas of restricted circulation and freshwater flow. During the dry season, these areas may become hypersaline. Primary threats to these areas are dumping, unnatural freshwater pulses, and future development.

Biscayne Bay Issues

Issues affecting the Biscayne Bay watershed are future urban and agricultural water supply and source protection.

Biscayne Bay Future Urban and Agricultural Water Supply and Source Protection

The following programs and projects are being implemented to ensure the protection of the water supply for the Biscayne Bay watershed:

- Wellfield protection programs designed to protect existing supply sources are being implemented in Miami-Dade, County. One of these projects is the completion of the Miami-Dade County ASR near existing wellfields by 2004.
- In addition to the *Lower East Coast Regional Water Supply Plan* (SFWMD, 2000b), the District has also initiated the development of several subregional plans. One of these plans is the South Miami-Dade County Integrated Water Resource Strategy.
- The construction of additional water control structures on the C-4 Canal in Miami-Dade County will also increase the level of water supply for the LEC Urban Area, with a major benefit of this project being to help restore the Everglades.
- The District will continue to update and implement the *Biscayne Bay SWIM Plan* (SFWMD, 1995b).
- MFLs will be established for Biscayne Bay by 2004.
- The District is currently engaged in providing for the acquisition, restoration, and management of the Pennsuco and Model Lands mitigation banking projects. Mitigation banking is a process by which wetland losses are mitigated in advance of a loss of wetlands to ensure that no net loss of wetland function occurs in a region.

Biscayne Bay Protection

Biscayne Bay protection issues include impacts to submerged aquatic and mangrove communities and the occurrence of several toxic metals at elevated levels, indicating persistent contamination sources.

Seagrasses. Impacts to seagrasses and other submerged aquatic communities are primarily caused by degraded water quality and physical disturbance. Land development activities destroy submerged aquatic communities by the direct impacts of dredge and fill, as well as by the indirect effects of polluted water and increased turbidity. Turbidity is also caused by boat propellers stirring up the bottom and boat wakes eroding shorelines. In general, seagrasses will tend to colonize any areas that are suitable for their survival and will not survive, even if they are transplanted, in areas that are unsuitable. For this reason, great care should be taken before seagrasses are removed under the pretext that they will be reestablished in another location. The best policy is to require that any proposed mitigation activities be successfully conducted prior to the removal of the original community.

Mangroves. The most direct threat to the mangrove communities of Biscayne Bay is land development along the shoreline and adjacent uplands. It is much more cost-effective to preserve the mangrove forests of Miami-Dade and Monroe counties than to institute costly treatment systems to replace the functions of the natural mangrove communities, such as retrofitting, water delivery, wetland restoration, flood control, and hurricane protection.

Everglades - Florida Bay

Background

The Everglades is the largest subtropical wetland in the United States and is a unique resource for South Florida. Everglades National Park was established in 1947, designated an International Biosphere Reserve in 1976, an Outstanding Florida Water in 1978, and a United Nations World Heritage Site in 1979. The park and the WCAs are the surviving remnants of the historical Everglades, which formerly spread uninterrupted from Lake Okeechobee south to Florida Bay and east to the coastal ridge. This remaining area provides significant ecological benefits including water storage and supply, habitat for wildlife of national significance, and internationally recognized recreational opportunities. The Everglades also encompasses the Western Basins area which contains two Native American Indian reservations. Big Cypress, the largest of the Seminole Tribe's reservations, occupies more than 52,000 acres in Hendry and Broward counties. The Miccosukee Tribe's reservation, just south of the Big Cypress Reservation, comprises 75,000 acres in Broward County.

To the south, Florida Bay has begun to demonstrate signs of stress. Historically, the bay was a 772-square mile, shallow, brackish estuary with fluctuating salinity. Salinity fluctuations were caused by changes in the season, outflow from the Everglades, and

rainfall. The bay was popular with sport fishermen because of the schools of tarpon, bonefish, redfish, and sea trout feeding on the pink shrimp, crabs, and other bait present. Large sections of the estuary have deteriorated in recent years. Hydrologic and geologic indicators of the deterioration of the estuary include murky water, loss of seagrass habitat, algal blooms, fish and invertebrate kills, and significant increases in salinity levels.

Resources

Significant natural systems resources within the Everglades-Florida Bay watershed include Everglades National Park, the WCAs, the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), the Crocodile National Wildlife Refuge, the Holey Land and Rotenberger WMAs, and the North Everglades Buffer Strip.

Specific Watershed Goals

The goals for the Everglades-Florida Bay watershed include the following:

- Preserve and protect existing Everglades water resources by restoring areas defined as degraded
- Eliminate or mitigate conditions that may lead to further decline
- Develop options for environmental enhancement

Status of Areas of Responsibility

Water Supply

With current water supply capabilities, irrigation demands for the EAA will become increasingly hard to meet.

Water Quality

High concentrations of phosphorus in water that flows into the Everglades have caused degradation of natural systems in some areas. Canals within the WCAs have high concentrations of nutrients, especially during the wet season, as a result of inflows from the EAA and other tributary basins. The major canals of the C&SF Project located in the EAA (L-8, West Palm Beach, Hillsboro, North New River, and Miami canals) have waters with high nutrients and low dissolved oxygen values. Pesticides, bacteria, and suspended solids have also been identified as problems. Agricultural runoff and seepage from sugar mill retention ponds are sources of pollutant loading to these canals. Backpumping water into the WCAs from the urban areas along the coast for flood protection and water storage has resulted in high nutrient concentrations and low concentrations of dissolved oxygen at perimeter sites. The continuation of rapid urbanization in the region could potentially result in increased loading of nutrients, pesticides, and heavy metals in waters discharged into the Everglades system. The 1994 Everglades Forever Act addresses the Everglades system and superseded the Everglades SWIM Plan.

The Western Basins represents a 711-square mile area of Broward, Collier, and Hendry counties that have been identified as also contributing nutrients to the Everglades. Some conversion of pasture and native range to citrus is anticipated in the future, which may further increase phosphorus levels.

Natural Systems

Construction and operation of the C&SF Project altered water levels, changed the volume, timing, and distribution of water flows, and changed water quality. This alteration of hydroperiod within the LEC region has impacted the WCAs and Everglades National Park. Also, exotic plant infestation is a particular problem in the Everglades. Brazilian pepper, melaleuca, and Australian pine are becoming increasingly abundant in many areas.

Everglades-Florida Bay Issues

Flood Control Versus Everglades Protection in the Western LEC Urban Areas, the South Dade Agricultural Area, and Water Protection Areas

Many of the ecological problems facing the Everglades National Park and Florida Bay are related to alterations in surface water flows, water depths, and hydropatterns associated with the flood control provided by the construction and operation of the C&SF Project. The existing schedule of water deliveries from the C&SF Project to Everglades National Park is being modified to lessen the adverse ecological impacts to the park. The East Everglades, located to the south of Tamiami Trail and west of the L-31N Canal in south central Miami-Dade County, encompasses the heart of Shark River Slough, the principal watershed of Everglades National Park. Therefore, restoring its surface water flows, water depths, and hydropatterns is critical to this initiative. Portions of the East Everglades have been settled and both agricultural and residential areas currently exist within the area. This land must either be acquired or existing flood protection must be maintained.

The Modified Water Deliveries to Everglades National Park Project will provide for the structural modifications to the C&SF Project. This is necessary to restore more natural water flows to Shark River Slough while maintaining the existing level of flood protection in the 8.5-Square Mile residential area.

8.5-Square Mile Area. Efforts to restore flows to the eastern Everglades have been complicated by the fact that agricultural and residential development has occurred in the area immediately adjacent to Everglades National Park. One area in particular, known as the 8.5 Square Mile Area (**Figure 32**), has been a topic of public debate for more than 20 years. It is a low-lying area west of the flood protection levee which was once part of the historic Everglades. At times, portions of the 8.5 Square Mile Area are subject to extensive flooding.

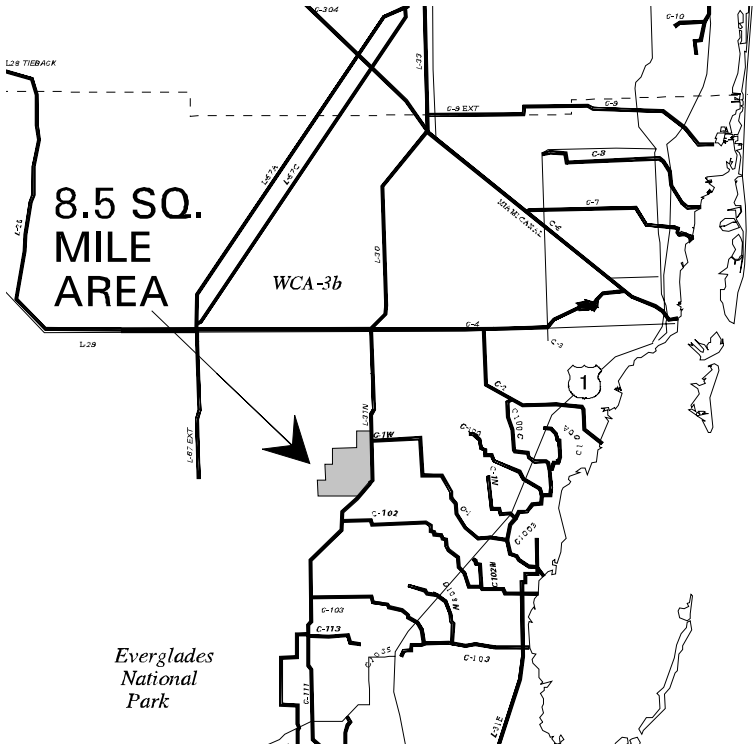

Figure 32. Location of the 8.5-Square Mile Area.

In 1989, Congress enacted the Everglades National Park Protection and Expansion Act. This law expanded the Everglades National Park to include 107,600 acres in the East Everglades, placing the boundary of the Everglades National Park immediately to the west of the 8.5 Square Mile Area. The legislation provided for historic flows to be restored, but recognized that given the hydrogeology of the region, restored overland flows would create higher water levels in the privately owned 8.5 Square Mile Area. In order to prevent adverse flood impacts to this area, the Modified Water Delivery Project includes the construction of a seepage levee and canal around the western and northern edges of the area and the relocation of Pump Station S-357 to remove excess seepage water. This relocation is scheduled to be completed by 2008.

Agricultural Activity in the Eastern Everglades. Levee 31 North runs north-to-south through Miami-Dade County and forms part of the eastern protective levee. It is one of the more prominent features of the C&SF Project and the original protective boundary between developed urban and agricultural areas and the Everglades. Construction of the eastern protective levee was intended to separate development from natural areas. However, agricultural activities were documented in the East Everglades beginning in 1956. This development and other structural changes resulted in a significant altering in the hydropattern, quantity, distribution, and timing of water flows within the Shark River Slough Basin. This impacted natural flow into northeastern Shark River Slough and left this area dependent on local rainfall and seepage for annual water flows. As a result, in Shark River Slough, wet season water depths dropped by more than a foot and the marsh experienced seasonal drawdowns during all but the wettest years. The CERP is addressing this issue with the L-31 North Levee Improvements for Seepage Management component. This component will eliminate water losses due to levee seepage to the east coast of

Florida. A pilot project will be conducted by 2004 to determine the appropriate technology to control the seepage and the appropriate amount of water flow that should be returned to Everglades National Park during the wet season.

Water Preserve Areas. As part of the overall Restudy effort, the Water Preserve Areas Feasibility Study, scheduled for completion in 2001, is investigating methods to capture and store excess surface waters that are normally released to tide via the C&SF Project canal system. This would be accomplished by backpumping these surface waters to a series of Water Preserve Areas for storage. Water Preserve Areas consist of a series of marshes, reservoirs, and ground water recharge areas. The Water Preserve Areas will provide the following system benefits:

- Prevent overdrainage of the Everglades and reestablishing natural hydropatterns within existing natural areas
- Provide for the re-creation of natural storage systems lost due to the impacts of development
- Provide for the increased spatial extent of short hydroperiod wetlands
- Provide a buffer between the Everglades and the increasingly urbanized LEC area
- Provide for an improved water supply to the LEC region

Water Preserve Areas will be constructed within the East Coast Buffer, which is located east of the WCAs in Palm Beach, Broward, and Miami-Dade counties. A series of marshes, reservoirs, and ground water recharge areas will be constructed to biologically treat storm water runoff from urban areas to the east and release it into the WCAs. This will reduce the impacts of development on the Everglades, reduce levee seepage from the Everglades, increase ground water recharge, capture storm water discharged to tide, and enhance wetland areas east of the WCAs. The acquisition of the East Coast Buffer is scheduled to be completed by 2018.

Mitigation banking is a process by which wetland losses are mitigated in advance of a loss of wetlands to ensure that there is no net loss of wetland function in a region. One such mitigation bank is the Buffer Strip Mitigation Bank. The District is currently acquiring, restoring, and managing Cells 17 and 18 within the mitigation bank.

Additional Water Control Structures. As part of the *Interim Plan for Lower East Coast Water Supply* (SFWMD, 1998c), the District recommended implementation of two water control structures on the C-4 Canal in Miami-Dade County. The eastern structure will maintain water levels in the vicinity of the western and northwestern wellfields. The western structure will restore hydroperiods in the Pennsuco Wetlands and allow for routing of water supply to the C-2 Canal for wellfield recharge. This recommendation is intended to reduce excess surface water runoff to tide, and to reduce the under-levee seepage that causes a loss of water from the Everglades system. In addition to ecosystem restoration benefits, the C-4 structures can be operated to provide an increased level of water supply and flood protection. The design of the Western C-4

Structure Critical Project will be completed during 2000 and construction will be initiated by 2001.

EAA Water Quality Management Providing High Quality Water to the Everglades

The SFWMD and other agencies have determined that high concentrations of phosphorus in water that flows into the Everglades are causing significant degradation in certain areas, often allowing cattails to displace native sawgrass habitats. These changes threaten fish and wildlife populations that are adapted to, or dependent upon, the vegetative makeup of the WCAs.

Everglades Works of the District Permit Program. The Everglades Works of the District Permit Program was implemented in 1992 pursuant to the provisions of the Marjory Stoneman Douglas Everglades Protection Act of 1991 (Chapter 373.4592, F.S.). It requires all EAA landowners holding property that discharge water to District works to obtain a Works of the District permit, implement Best Management Practices (BMPs), and monitor the quality and quantity of waters discharged from their lands into the District's works. Research is being conducted to determine the effectiveness of BMPs.

Stormwater Treatment Areas. The District will continue management of the Everglades Nutrient Removal (ENR) Project and other Stormwater Treatment Areas (STAs). The District will also conduct ENR research to optimize STA performance by 2004.

Everglades Construction Project. The Everglades Construction Project (ECP) includes the design and construction of various STAs, pump stations, and other capital facilities necessary to restore the Everglades, consistent with the Everglades Forever Act. It is scheduled for completion in 2006.

Everglades and Florida Bay Restoration

Major problems confronting the Everglades-Florida Bay system include the following:

- Reduction of the original Everglades ecosystem by half has placed a limitation on its capacity to support populations of wildlife that once used the area in much greater numbers.
- Fragmentation of the Everglades system has resulted in the loss of connections between the central Everglades and adjacent transitional wetlands.
- Changes in timing, distribution, and quantity of water discharges into and within the freshwater wetlands and estuarine systems has resulted in loss or degradation of native plant communities, loss or destruction of the habitats of threatened and endangered plants and animals, and a decline in commercial and recreational fisheries.

- Water quality associated with discharges from the EAA and other basins has impacted the natural Everglades ecosystem.
- Hypersalinity and algal blooms in Florida Bay

Decompartmentalization of the Water Conservation Areas. To reestablish the ecological and hydrologic connection between these areas, flow obstructions will be removed to allow unconstrained, passive flow between WCA-3A and WCA-3B and Northeast Shark River Slough. Two of the components of this project, rerouting the Miami Canal and adding the S-345 structures, will be implemented by 2009.

Reducing Seepage from WCA-3A and WCA-3B. Reducing seepage from WCA-3A and WCA-3B will improve hydropatterns within the WCAs by utilizing the marsh areas that are located east of the WCAs and west of U.S. 27. Seepage from the marshes will be collected and returned to the WCAs to maintain flood protection. Construction of seepage management features will be completed by 2008.

C-111 Project. The C-111 Project will restore the Taylor Slough portion of the Everglades. Completion of structural and nonstructural modifications to the C-111 are scheduled for completion by 2004. One component of the C-111 project is the Pineland and Hardwood Hammock Restoration Project. In this project a 200-foot wide strip of land within the Frog Pond will be used to test and demonstrate the techniques required to reestablish native conifer and tropical hardwood forest on land that has been rock plowed. The Frog Pond is located in south Miami-Dade County, just east of Everglades National Park. The Pineland and Hardwood Hammock Restoration Project is scheduled to be completed by 2006. Flood protection within the C-111 Basin east of the L-31N and C-111 canals will be maintained while the project is being implemented.

Other Projects to Restore Flows and Hydropatterns. The current Holey Land and Rotenberger WMAs regulation schedule will be revised by 2001 and Pump Station G-404 will be modified by 2009. Several planning activities will help improve the hydropatterns within the Everglades: establishment of MFLs for the WCAs and Everglades National Park by 2000; implement rain-driven delivery schedules for WCA-1, WCA-2A, WCA-3A and the Rotenberger WMA by 2003; establishment of economic and hydrologic needs of the Everglades Protection Area by 2004. The District will continue to publish Everglades research results on food webs, wading birds, and hydrologic impacts.

Everglades Stormwater Program. The primary goal of the Everglades Stormwater Program is to ensure that state water quality standards are achieved, to the maximum extent practicable, by December 31, 2006, at all water control structures included in the Non-Everglades Construction Project permit issued by the FDEP (SFWMD, 2000e).

Treating C-11 Runoff. Untreated runoff from the western C-11 Basin, which is presently backpumped through the S-9 Pump Station into WCA-3A, will be diverted from the North New River and C-9 canals to the Central and North Lake Belt storage areas. Once the water is treated it will be backpumped into WCA-3A. This will 1) restore a

portion of water deliveries to WCA-3A that are eliminated by segregating the C-11 runoff from levee seepage, 2) reduce stages within WCA-2B, and 3) divert water through WCA-3A and WCA-3B to northeastern Shark River Slough. The completion of the Western C-11 (S-9) Water Quality Treatment Project is scheduled to be completed by 2002. Capturing excess flows from WCA-3A and diverting them to the Central Lake Belt Storage Area and capturing excess flows from the Central Lake Belt Storage Area and diverting them to WCA-3B are scheduled to be completed by 2016 and 2017, respectively.

Hypersalinity and Algal Blooms in Florida Bay. In recent years, Florida Bay has demonstrated signs of stress. Large sections of the once pristine water body have deteriorated, with murky water, seagrass and sponge die-offs, algal blooms, fish kills, and an increase in salinity levels. Samples taken from central Florida Bay in 1989 and 1990 showed that salinity levels within the bay were higher than in the Atlantic Ocean. As the water in the bay has increased in salinity, biodiversity has declined. The absence of hurricanes in recent years reduced the beneficial flushing action, and the drought of the late 1980s exacerbated the problems of the bay. Die-offs of seagrasses compound the problems, allowing the barren bottom to release more sediment and nutrients, which causes the water to become turbid. Algal blooms erupted and spread, killing more seagrass and sponges. By 1992, more than 450 square miles of Florida Bay was suffering from algal blooms, creating an area which scientists and fishermen named the Dead Zone. Though the size of the Dead Zone has since decreased, it is still extremely large. To address this issue, the District will conduct Florida Bay research on seagrass mortality and algal blooms and research on the effects of freshwater inflow on the mangrove transitional zone. A Florida Bay Feasibility Study will comprehensively evaluate the Florida Bay and determine the types of modifications that are needed to successfully restore the water quality and ecological conditions of Florida Bay. Both the research and the feasibility study are scheduled for completion in 2004.

Exotics Infestation

Melaleuca was first introduced into South Florida from Australia in the early 1900s. Since that time, it has rapidly invaded many natural areas in the region, creating dense monocultures which may displace native plant communities and alter wildlife value. It currently infests thousands of acres in the Everglades, and is very persistent and hard to eradicate. The largest infestations occur in portions of the WCAs. The District will continue its aquatic and upland exotic plant control efforts.

Florida Keys

Background

The Florida Keys watershed consists of a limestone island archipelago of some 1,700 islands extending southwest over 200 miles, from the southern tip of the Florida mainland to the Dry Tortugas. The area is bounded on the north and west by the relatively shallow mud shoals and the seagrass beds of Biscayne Bay, Barnes and Blackwater Sounds, Florida Bay, and the Gulf of Mexico. Fresh water is supplied to the Florida Keys

by the Florida Keys Aqueduct Authority which has a wellfield near Florida City on the mainland.

Resources

The Florida Keys watershed has extensive shoreline and marine resources, including mangroves, coral reef formations, seagrass beds, wetlands, and fish and wildlife and their habitat.

Specific Watershed Goals

Goals for the Florida Keys watershed are as follows:

- Protect shoreline and marine resources, including mangroves, coral reef formations, seagrass beds, wetlands, and fish and wildlife and their habitat
- Protect freshwater wetlands, including wildlife and their habitat
- Limit the adverse impacts of development on the quality of water throughout the Florida Keys
- Protect the value, efficiency, cost-effectiveness, and amortized life of public investments, including the Florida Keys Aqueduct Authority

Status of Areas of Responsibility

An area of responsibility which has issues relating to the Florida Keys watershed is natural systems.

Natural Systems

Public Law 101-605 designated 2,600 square nautical miles of coastal waters as the Florida Keys National Marine Sanctuary. This law requires the U.S. Secretary of Commerce to develop a comprehensive management plan and the necessary regulations to protect the sanctuary's resources. It further charges the Administrator of the U.S. Environmental Protection Agency (USEPA) and the Governor of Florida to develop a comprehensive water quality protection program for the sanctuary. The SFWMD has been, and will continue to be, actively involved in all phases of the water quality protection program, which is being developed under the direction of the National Ocean and Atmospheric Administration (NOAA).

Florida Keys Issues

An issue affecting the Florida Keys is nearshore water quality.

Florida Keys Nearshore Water Quality

Historically, nearshore water quality in the Florida Keys has been good because of rapid flushing and dilution. Despite its high quality, water in the Florida Keys is subject to pollution from wastewater treatment plants, septic tanks, cesspools, and storm water runoff. These sources of pollution produce changes in nutrient levels and turbidity, as well as introduce toxics into the nearshore waters, which can have disastrous impacts on the coral reefs and other natural resources. The District will continue to address these issues by developing and implementing a Florida Keys Water Quality Plan.

The Florida Keys Tidal Restoration Project will restore the tidal connection between Florida Bay and the Atlantic Ocean in Monroe County that was eliminated in the early 1900s during the construction of Flagler's railroad. Restoring the circulation to areas of surface water that have been impeded and stagnant for decades will significantly improve water quality, benthic floral and faunal communities, larval distribution of both recreational and commercial species (i.e. spiney lobster), and the overall hydrology of Florida Bay. The connections will be restored by the construction of bridges or culverts at four locations (see **Chapter 6** for more details). The Florida Keys Tidal Restoration Project is scheduled to be completed by 2005.

Lower East Coast Regional Watershed Strategies

The SFWMD has proposed strategies to address the issues within the LEC regional watershed. These strategies are identified by area of responsibility and core objective, and implemented through budget activities (or projects). More generalized tasks that cover more than one regional watershed are not discussed within this chapter. Therefore, not all core objectives are discussed within this chapter, even if the projects will benefit the watershed. These Districtwide tasks, along with a more complete description of the tasks mentioned below, are presented in **Chapter 3** through **Chapter 6**.

Water Supply

Core Objective WS 1: Increase available water supplies and maximize overall water use efficiency to meet identified existing and future needs

Planning

- Begin implementation of the Northern Palm Beach County Water Resources Development Program by 2001
- Initiate reclaimed water system for irrigation in Palm Beach/Martin County in 2000.
- Complete a East Broward County Integrated Water Resource Strategy by 2001
- Complete a Southeast Palm Beach County Integrated Water Resource Strategy by 2004

Land Acquisition

- Complete acquisition of the East Coast Buffer by 2018

Public Works Construction

- Construct the Western Hillsboro (Site 1) ASR Pilot Project by 2003; complete well construction by 2014
- Carry out and begin monitoring of the L-31 North Seepage Management Pilot Project by 2004
- Construct the WCA-3A and WCA-3B seepage management features by 2008
- Complete the Broward County Secondary Canal System by 2009
- Carry out the Lake Belt Technology Pilot Project by 2012
- Complete the Southern L-8 In-Ground Reservoir General Reevaluation Report (GRR) by 2014
- Divert excess flows from WCA-3 to the Central Lake Belt Storage Area by 2016
- Divert excess flows from the Central Lake Belt Storage Area to WCA-3B by 2017
- Complete the Hillsboro (East) ASR Pilot Project in southern Palm Beach County in 2002
- Implement the *Lower East Coast Regional Water Supply Plan*
- Complete the Miami-Dade County ASR Project in 2004

Operations and Maintenance

- Develop and implement a Water Supply and Environmental (WSE) schedule for Lake Okeechobee as recommended in the *Lower Coast Regional Water Supply Plan*
- Develop rain-driven operating rules for the greater Everglades and the CERP components
- Implement the operational modifications recommended in the *Lower East Coast Regional Water Supply Plan*

Regulation

- Establish enhanced water conservation requirements for water users with rulemaking by 2001

Outreach

- Complete the Hillsboro (East) ASR Pilot Project by 2002
- Implement the *Lower East Coast Regional Water Supply Plan* by 2004
- Complete Miami-Dade County ASR from existing wellfields by 2004
- Establish a water conservation coordinator in 2000

Monitoring and Evaluation

- Continue to implement the LEC Water Resource Development Program
- Implement hydrologic studies

Flood Protection and Floodplain Management

Core Objective FP 1: Minimize damage from flooding

Public Works Construction

- Maintain flood protection while implementing the Modified Water Delivery Project by 2003
- Maintain flood protection within the C-111 Basin east of the L-31N and C-111 canals while implementing the C-111 Project by 2004

Monitoring and Evaluation

- Continue conducting flood studies in the C-17 and C-51 basins

Water Quality

Core Objective WQ 1: Protect and improve surface water quality

Planning

- Conduct the Florida Bay Feasibility Study by 2004
- Continue developing a Florida Keys Water Quality Plan
- Continue to implement the *Lake Okeechobee SWIM Plan*
- Update the Lake Okeechobee SWIM Plan by 2000

Public Works Construction

- Complete the Lake Okeechobee Water Retention/Phosphorus Removal Critical Project by 2002
- Complete the Western C-11 (S-9) Water Quality Treatment Project by 2002
- Carry out Lake Okeechobee Tributary Sediment Dredging by 2005

- Complete the ECP by 2006
- Finish Pineland and Hardwood Hammock Restoration project (C-111 Basin) by 2006

Operations and Maintenance

- Continue to operate and maintain the canals, levees, pipes, culverts, pump stations, and test cells within the ECP

Regulation

- Continue Everglades Works of the District permitting
- Continue developing the Everglades Storm Water Program
- Continue Lake Okeechobee Works of the District permitting

Monitoring and Evaluation

- Continue ECP research and data collection efforts
- Continue Everglades BMP effectiveness research and develop a chapter on BMPs for the Everglades Consolidated Report by 2001
- Continue water quality monitoring in Florida Bay
- Continue Lake Okeechobee research and data collection efforts
- Continue monitoring the test cells within the ECP

Core Objective WQ 2: Protect and improve ground water quality

Planning

- Complete the Water Preserve Area Feasibility Study by 2001

Monitoring and Evaluation

- Complete the Lake Okeechobee ASR Pilot Project by 2004

Natural Systems

Core Objective NS 1: Maintain the integrity and functions of water resource-related natural systems

Planning

- Establish MFLs for Everglades National Park, the WCAs, Lake Okeechobee, and most of the Biscayne aquifer by 2000
- Implement rain-driven delivery schedules for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (WCA-1), WCA-2A, and WCA-3A, and the Rotenberger WMA by 2003

- Establish MFLs for Florida Bay by 2003
- Continue In-Lake Research on water level impacts on Lake Okeechobee
- Continue to establish minimum and maximum flows to the Lake Worth Lagoon

Land Acquisition

- Continue to provide for the acquisition, restoration, and management of the Cells 17 and 18 Mitigation Project
- Continue to provide for the acquisition, restoration, and management of the Pennsuco Wetlands Mitigation Project
- Continue to provide for the acquisition, restoration, and management of the K-Mart Mitigation Project

Monitoring and Evaluation

- Continue Lake Okeechobee research and data collection

Core Objective NS 2: Restore degraded water resources and related natural systems to a naturally functioning condition

Planning

- Update the Lake Okeechobee SWIM Plan by 2000
- Implement rain-driven delivery schedules for the Arthur R. Marshall Loxahatchee Wildlife Refuge (WCA-1), WCA-2A, WCA-3A, and the Rotenberger WMA by 2003
- Establish the ecological and hydrologic needs of the Everglades Protection Area by 2003
- Continue to develop the South Miami-Dade County Integrated Water Resource Strategy
- Continue the Biscayne Bay SWIM planning process and establish a MFL for Biscayne Bay by 2004

Public Works Construction

- Construct the Western C-4 Structure by 2001
- Complete structural and nonstructural modifications to the C-111 Project by 2004
- Implement the Modified Water Deliveries Project by 2004
- Complete the Florida Keys Tidal Restoration Project by 2005
- Relocate the S-357 structure by 2008 to provide more effective water deliveries to Everglades National Park

- Complete G-404 Pump Station modifications by 2009
- Reroute the Miami Canal by 2009
- Add the S-345 structures by 2009 to establish more natural hydropatterns and hydroperiods in northeastern Shark River Slough and WCA-3B
- Complete the Lake Worth Lagoon Restoration by 2011

Operations and Maintenance

- Continue exotic species control in the Everglades
- Revise the current Holey Land WMA Regulation Schedule by 2001
- Revise the current Rotenberger WMA Regulation Schedule by 2001
- Continue ongoing elimination of exotic species from around Lake Okeechobee

Outreach

- Continue to implement the Biscayne Bay SWIM Plan

Monitoring and Evaluation

- Conduct ENR research to optimize STA performance by 2004
- Conduct Florida Bay research on seagrass mortality and algal blooms by 2004
- Conduct Florida Bay research on freshwater inflow effects on mangrove transitional zone by 2004
- Continue to publish Everglades research results on food webs, wading birds, and hydrologic impacts
- Continue hydrologic monitoring in Lake Okeechobee, the Everglades, and Florida Bay
- Continue Lake Okeechobee research and data collection efforts
- Continue implementing the *Lake Okeechobee SWIM Plan*

LOWER WEST COAST REGIONAL WATERSHED

Overall Lower West Coast Regional Watershed

The Lower West Coast (LWC) region presently has one of the highest population growth rates in the state and this trend is projected to continue. In addition to significant urban population growth, the LWC has experienced notable growth in agricultural activity. Citrus acreage grew significantly in this region following a series of freezes in Central Florida in the 1980s. Population growth and an increase in irrigated agricultural acreage have resulted in demands for more water for urban and agricultural use.

The LWC regional watershed contains two major watersheds formed by ten drainage basins. These two major watersheds are the Caloosahatchee River and the Big Cypress Basin watersheds.

Regional Watershed Goals

The regional watershed goals are to identify sufficient sources of water and funding to meet the needs of all reasonable-beneficial uses within the LWC region through 2020 during a drought event that has the probability of occurring no more frequently than once every ten years, while sustaining the water resources and related natural systems (SFWMD, 2000c).

Status of Areas of Responsibility

The four areas of responsibility are water supply, flood protection and floodplain management, water quality, and natural systems. A summary of the status of each area of responsibility within the LWC region is provided below.

Water Supply

The Surficial Aquifer System is the primary source of municipal, industrial, and agricultural water supply in the LWC region. Areas close to the Caloosahatchee River have access to some surface water for supply, but the remainder of the region utilizes ground water or limited surface water that can be found locally. Urban water demands are projected to increase by 84 percent between 1995 and 2020. Irrigated agricultural demand is projected to increase by 21 percent over the same time period (SFWMD, 1998b).

All of Lee County and the coastal portions of Collier County are currently designated as Reduced Threshold Areas (RTAs) and 87 percent of the LWC region is included in a Water Resource Caution Area (WRCA) (**Chapter 3**). RTAs are established as a precautionary measure when water demand approaches or exceeds supply capacity. However, the District is involved in rulemaking to drop the RTA designated for these areas.

The *Lower West Coast Water Supply Plan* (SFWMD, 2000c) accomplished the following:

- Assessed existing and projected future (2020) agricultural and urban water demands
- Developed strategies to meet these needs, while providing adequate water to support the needs of the environment
- Identified specific geographical areas that have water resource problems that are critical or are anticipated to become critical by 2020
- Established a framework around which future water use decisions in the planning region can take place
- Identified data collection and technical studies needs

Flood Protection and Floodplain Management

Southwest Florida is one of the most hurricane vulnerable areas in the country. Flooding from tropical storms and hurricanes occurs in low lying areas, along barrier islands, and around river and bay systems. Hurricane storm surge inundation modeling indicates that extensive areas of Lee and Collier counties could be flooded in a major hurricane. These correspond to areas already developed for urban use and areas anticipated for future urban growth.

The primary waterway serving the LWC is the Caloosahatchee River, which traverses Glades, Hendry, and Lee counties. Except for localized canal systems, the only other major waterway is the system of canals in western Collier County. Most of the canals in Hendry and Glades counties are privately-owned within large tracts of land.

The major constraints on flood control upgrades in this area are environmental and financial. The basic issue becomes one of the value to the public of improved flood control versus the potential for environmental deterioration. The high cost of implementation delays or prohibits many designs which provide structural flood control without adverse environmental effects.

Water Quality

The SFWMD has identified several water bodies within the LWC regional watershed as candidates for SWIM Plans. These include the Big Cypress National Preserve, Caloosahatchee River, Corkscrew Swamp, Naples Bay, Estero Bay, Pine Island Sound, Rookery Bay, and Lake Trafford.

The operation and maintenance of canal systems, particularly through discharges to tidal waters, have impacted the water quality and natural resource features of the LWC region. Serious problems have occurred at the mouth of the Sanibel River on Sanibel Island, located in San Carlos Bay, within the Charlotte Harbor watershed. Domestic wastewater and runoff from Sanibel Island development were the major sources of this

problem. Improvements to wastewater treatment plants have controlled the leachate problem, though runoff continues to be a problem. Water quality in the other areas of the Charlotte Harbor watershed within the SFWMD is generally good. Large regulatory releases of fresh water from Lake Okeechobee to the Caloosahatchee River during times of heavy rainfall adversely impact the health of the estuaries associated with the river.

Natural Systems

The natural resource features in portions of the LWC region have been substantially altered from the natural conditions by agricultural and urban development. The development of citrus groves significantly influences the natural systems of the region. Planning and research are currently under way to evaluate reasonable options for mitigating changes resulting from the migration of citrus to the LWC region. Although water quality is a concern, changes to the habitat and the reduction of ground water levels in wetlands are of even greater concern. Infestation by exotic plants, particularly melaleuca, is a significant problem in portions of this area.

Caloosahatchee River

Background

The Caloosahatchee River and Estuary extend about 70 miles from Lake Okeechobee to San Carlos Bay on Florida's southwest coast. This watershed includes the East, West, and Tidal Caloosahatchee drainage basins; and the North Coastal, Telegraph Swamp, C-21, and S-236 drainage basins. The freshwater portion of the river has been reconfigured as a canal (C-43), extending 45 miles from the Moore Haven Lock and Dam (S-77) to Franklin Lock and Dam (S-79), to better convey flood water to the Gulf of Mexico.

Resources

Significant natural system resources within the Caloosahatchee River watershed include Pine Island Sound, Matlacha Pass, Charlotte Harbor aquatic preserves, and Telegraph Swamp.

Specific Watershed Goals

The goal of the *Caloosahatchee River Watershed Management Plan* (SFWMD, 2000d) is to protect and enhance the estuaries that receive freshwater regulatory releases from Lake Okeechobee through the Caloosahatchee River.

Caloosahatchee River Watershed Issues

The major issues affecting the Caloosahatchee River watershed are water supply availability, Caloosahatchee River salinity variations, and Caloosahatchee River nutrient levels.

Caloosahatchee River Watershed Water Supply Availability

The water availability issues affecting the Caloosahatchee Basin are limited surface water sources; protection of water resources and associated natural systems; and pressure on these resources from increasing urban and agricultural demands. Increasing urban and agricultural water demands have the potential to adversely impact the region's water resources and associated natural systems. Ground water is the most important source of supply for most of the LWC region, but the Caloosahatchee River is an important surface water source in the northern portion of the region. Rapid growth in population and irrigated agricultural acreage has caused demands for water to increase significantly. Increased withdrawals in the future may cause ground water levels to decline and potentially impact wetlands. Additionally, increased demands may cause saltwater intrusion if unrestricted in the surficial and lower Tamiami aquifers along the coastlines of Lee and Collier counties. The SFWMD reviewed the problems of wetland protection, intrusion of seawater into aquifers, and general protection of aquifers from excessive drawdowns in the *Lower West Coast Water Supply Plan* (SFWMD, 2000c).

Supply augmentation options include ASR, increased surface water storage, and increased implementation of reuse programs. Alteration of demand patterns, through increased conservation measures, can also aid in meeting the water supply needs of this region. One such project, the Caloosahatchee ASR Pilot Project, will be constructed by 2006.

Caloosahatchee River Salinity Variations

Alteration of freshwater flow is a key environmental issue in the Caloosahatchee River Estuary. Lake Okeechobee regulatory releases and uncontrolled runoff from the Caloosahatchee River subbasins have resulted in too much fresh water entering the estuary too frequently, causing wide salinity variations that are destructive to estuarine communities. At the other extreme, during low flow conditions, too little water has been available. Low flow conditions allow saline water to migrate upstream threatening public drinking water supplies.

The first phase of a three dimensional model of the Caloosahatchee River is under development. This model will enable a quantitative evaluation of the effects of differing river water discharges.

The District is currently establishing MFLs for Lake Okeechobee, which will include limiting large regulatory releases and uncontrolled runoff from Lake Okeechobee into the Caloosahatchee River. The strategies for this project are discussed within the **Lower East Coast Regional Watershed** section.

Caloosahatchee River Nutrient Levels

Low dissolved oxygen levels and algal blooms have been observed near the Olga Treatment Plant intake. As a result the water quality is rated fair in this segment of the Caloosahatchee River (Paulic and Hand, 1998). The most likely causes of these problems

are agricultural runoff and the influence of nutrient enriched waters from Lake Okeechobee. Within the estuarine portion of the Caloosahatchee River elevated nutrient concentrations, especially phosphorus, and low water column transparencies have been identified. This portion of the drainage basin is highly developed and nonpoint sources impact water quality.

As mentioned in the **Lower East Coast Regional Watershed** section, the establishment of MFLs for Lake Okeechobee will limit the amount of water released from Lake Okeechobee into the Caloosahatchee River.

Big Cypress Basin

Background

The western Big Cypress Basin includes the Estero and Imperial river basins of Lee County, and a 1,200-square mile area drained by many natural sloughs and about 170 miles of primary canals. These primary canals are operated and maintained by the Big Cypress Basin Board. The eastern Big Cypress Basin watershed (east of State Road 29) includes vast natural areas presently occupied by the Big Cypress National Preserve, and the western part of the Everglades National Park.

Resources

Significant natural system resources within the Big Cypress Basin include Big Cypress National Preserve, Florida Panther National Wildlife Refuge, Fakahatchee Strand State Preserve, Southern Golden Gate Estates, Belle-Meade Royal Palm Hammock, Camp Keis Strand, Okaloacoochee Slough, Cape Romano-Ten Thousand Islands, Rookery Bay and Estero Bay aquatic preserves, Collier-Seminole State Park, Corkscrew Regional Ecosystem Watershed (CREW), Twelve Mile Slough, and Six Mile Cypress Slough.

Some large natural systems, such as Big Cypress National Preserve, Fakahatchee Strand, and CREW, are relatively intact. The CREW covers nearly 55,000 acres in Collier and Lee counties. It provides numerous water resource benefits including critical wildlife habitat for a number of rare, threatened, or endangered species. These large systems are especially dominant in the southern half of the region. State land acquisition efforts are bringing more of the area under protection. Large coastal areas have been protected by the establishment of six state aquatic preserves in the region: Cape Romano-Ten Thousand Islands, Rookery Bay, Pine Island Sound, Matlacha Pass, Charlotte Harbor, and Estero Bay.

Specific Watershed Goals

The goal for the Big Cypress watershed management plan is to conserve and protect the natural resources and scenic beauty of the area, while maintaining the level of service of flood protection, water supply, and water quality for a robustly urbanizing region.

Big Cypress Basin Issues

The major issues affecting the Big Cypress Basin are water supply availability, hydrologic restoration projects like the Southern Golden Gate Estates, prevention of flooding in southern Lee County, particularly in Bonita Springs, and enhancement of the level of service of the Big Cypress Basin canals for flood protection and aquifer recharge.

Big Cypress Basin Water Availability

This issue is discussed in the **Overall Lower West Coast Regional Watershed** section

Southern Golden Gate Hydrologic Restoration

Southern Golden Gate Estates encompasses an area of 94 square miles and is part of a bankrupt real estate development project undertaken in the 1960s. Prior to development, the area was characterized by seasonal flooding several months of the year. Broad, slow moving sheetflow sustained wetland vegetation and rejuvenated freshwater aquifers. A network of roads intercepts historic flowways. Forty-eight miles of canals over drain the landscape and quickly divert surface and ground water flow to a point discharge into the Faka Union Bay, thus damaging the ecology of the Ten Thousand Islands Estuary.

Southern Golden Gate Estates was identified in 1985 as a component of the Governor's Save Our Everglades Program and is included in the state's Conservation and Recreation Lands (CARL) Program. Land acquisition, which is a key component of the restoration, is being administered by the FDEP. The primary restoration goals are as follows:

- Reestablish historic flowways, sheetflow, and hydroperiods of wetlands to near historic levels
- Reduce point discharges to improve the health and productivity of downstream estuaries
- Maintain flood protection for developed areas north of the Southern Golden Gate Estates project
- Improve aquifer recharge for water supply and a saltwater intrusion barrier
- Restore and enhance habitat for fish and wildlife resources including listed species such as the Florida panther, Florida black bear, and wood stork, as well as rare habitat such as tropical hammocks and plant species, including orchids and bromeliads
- Preserve upland habitat
- Control invasive exotic plants
- Improve water quality of storm water runoff
- Reduce or eliminate overdrainage of adjacent, sensitive ecosystems

- Provide resource-based recreational opportunities
- Provide contiguous habitat conservation for the greater Everglades ecosystem including the Florida Panther National Wildlife Refuge, Fakahatchee Strand State Preserve, Ten Thousand Islands National Wildlife Refuge, Collier Seminole State Park, and the Belle Meade CARL area

At the request of the Governor of Florida, the SFWMD has developed a Hydrologic Restoration Plan for Southern Golden Gate Estates. The primary components of the restoration plan are as follows:

- Acquisition of approximately 55,000 acres of land
- Construction of 2.4 miles of spreader channels, 83 canal plugs, 130 miles of road removal and regrading, and three pump stations with a combined discharge capacity of 860 cfs
- Ecological and hydrological monitoring program to determine effectiveness
- Adaptive management to ensure desirable ecological responses

This project is planned to be implemented in partnership with the U.S. Army Corps of Engineers (USACE) after completion of acquisition of all of the project land under public ownership.

Bonita Springs Flooding

During 1995, extensive flooding occurred in Lee and Collier counties, particularly in the Bonita Springs area. The area has not maintained the natural regional drainage system and the flooding was caused by a combination of numerous high intensity rainfall events, coupled with wet antecedent moisture conditions. The existing conveyance capacity of the Estero River, Halfway Creek, Spring Creek, Camp Keis Strand, Cocohatchee River, and Imperial River in southern Lee County and northern Collier County were inadequate to handle the vast amounts of flood water from the combined watersheds. Flooding of the residential areas in both the Imperial and the Cocohatchee watersheds in southern Lee and northern Collier counties occurred twice during 1995.

The *South Lee County Watershed Study* (Johnson Engineering, Inc., 1997), a result of the flooding in 1995, was completed in May 1997. The main recommendations from this study are to continue to protect and enhance major flowways and pursue an active land acquisition program in the CREW area and the Imperial River flowway.

Since the flooding of 1995, the Imperial River has been cleaned from Oak Creek to Bonita Grande Road. Exotics and trash were removed and low vegetation blocking the flow was trimmed. The Kehl Canal weir has been replaced with a permanent, operable structure. The Imperial Bonita Estates Bridge, a major constriction in 1995, has been replaced with a larger bridge. The Estero River has been cleaned from U.S. 41 to the

north/south fork, and efforts are presently under way to finish the cleaning to I-75. Halfway Creek is presently being cleaned from U.S. 41 to a mile west of U.S. 41. The Florida Power and Light (FP&L) Bridge is being replaced to increase flow. The natural flowway for Halfway Creek from U.S. 41 to I-75 is being recreated by the Brooks Development. Also, a connection from U.S. 41 to the channel to the west is being discussed with a proposed development. The last major project is the land acquisition east of Bonita Grande Road and the Imperial River flowway for flood reduction, water recharge, and enhancing the environment. Approximately 1,000 acres of the 4,670-acre project have been purchased using CARL funds, and a $7 million grant from the Department of the Interior has been accepted for some of the land acquisition related to this project. District staff will continue to work with new developments to protect and enhance the major flowways. A South Lee County Watershed Plan, scheduled for completion by 2003, will address the issue of minimizing flood-related damage.

Lower West Coast Regional Watershed Strategies

The SFWMD has proposed strategies to address the issues within the LWC regional watershed. These strategies are identified by area of responsibility and core objective, and implemented through budget activities (or projects). More generalized tasks that cover more than one regional watershed are not discussed within this chapter. Therefore, not all core objectives are discussed within this chapter, even if the projects will benefit the watershed. These Districtwide tasks, along with a more complete description of the tasks mentioned below, are presented in **Chapter 3** through **Chapter 6**.

Water Supply

Core Objective WS 1: Increase available water supplies and maximize overall water use efficiency to meet identified existing and future needs

Planning

- Complete the *Lower West Coast Water Supply Plan* during 2000
- Finalize the *Caloosahatchee Water Management Plan* during 2000
- Finalize the *Big Cypress Basin Watershed Management Plan* by 2001

Public Works Construction

- Construct the Caloosahatchee ASR Pilot Project by 2006
- Implement the water resource development projects recommended in the *Lower West Coast Water Supply Plan*

Outreach

- Implement the *Lower West Coast Water Supply Plan*

Core Objective WS 2: Prevent contamination of water supplies

Monitoring and Evaluation

- Develop criteria to support rulemaking for the LWC region by 2003

Flood Protection and Floodplain Management

Core Objective FP 1: Minimize flood-related damage

Planning

- Implement flood control elements through the Basin Board's Capital Projects Construction Program.
- Develop a South Lee County Watershed Plan by 2003

Water Quality

Core Objective WQ 1: Protect and improve surface water quality

Monitoring and Evaluation

- Complete Phase II of the Estero Bay/watershed assessment by 2003
- Continue LWC water quality monitoring from Cape Romano to the Caloosahatchee River
- Continue water quality monitoring of inland canals, lakes, and streams within the Big Cypress Basin in cooperation with Collier County

Core Objective WQ 2: Protect and improve ground water quality

Monitoring and Evaluation

- Develop a scientific basis for wetland protection criteria used in water use and environmental resource permitting by 2003

Natural Systems

Core Objective NS 1: Maintain the integrity and functions of water resources and related natural systems

Planning

- Complete the Southwest Florida Feasibility Study by 2004
- Continue updating the *Big Cypress Basin Watershed Management Plan*

Land Acquisition

- Continue to provide for the acquisition, restoration, and management of the CREW mitigation project

Regulation

- Continue to develop regulation criteria for the LWC region
- Continue to develop rules for low-level releases of water from Lake Okeechobee to the Caloosahatchee Estuary

Core Objective 2: Restore degraded water resources and related natural systems to a naturally functioning condition

Public Works Construction

- Complete the Tamiami Trail Culverts (West) Critical Project by 2002
- Complete the Tamiami Trail Flow Enhancement project by 2002
- Carry out the Lake Trafford Critical Ecosystem Restoration Project development by 2003, in cooperation with USACE and Florida Fish and Wildlife Conservation Commission (FWC)
- Complete Lake Trafford Sediment Removal project by 2005
- Complete the Southern Golden Gate Estates Hydrologic Restoration Project by 2010, in partnership with the USACE
- Divert a portion of peak wet season flow of the Golden Gate Main Canal to Henderson Creek to improve Naples Bay Estuary by 2006

UPPER EAST COAST REGIONAL WATERSHED

The Upper East Coast (UEC) is composed of St. Lucie and Martin counties and eastern Okeechobee County. The region covers over 1,200 square miles and has an average elevation of 20 feet. Annual average rainfall in the watershed region is about 51 inches, with almost three-fourths of this rainfall occurring during the May to October wet season. The UEC is predominantly agricultural, mainly citrus, especially in St. Lucie County and in the western portions of the region. The existing population is concentrated in the coastal areas of Martin and St. Lucie counties. These areas are expected to remain the population centers for the region. The UEC consists almost entirely of the Indian River Lagoon watershed.

Regional Watershed Goals

The watershed goals for the UEC are as follows:

- Promote the use of conservation and water supply alternatives within the UEC
- Develop the relationship between water use, water levels, and water quality for the Floridan Aquifer System within the UEC
- Protect wetland systems from harm due to water use drawdowns in the UEC
- Protect the Surficial Aquifer System from saltwater intrusion
- Establish a uniform level of certainty for all UEC permitted water uses and for the environment
- Promote compatibility between the SFWMD Plans and local land use decisions and policies
- Protect and enhance the St. Lucie Estuary and the Indian River Lagoon
- Promote coordination, compatibility, and integration of regional water resource planning efforts

Indian River Lagoon

Background

The Indian River Lagoon is a series of three distinct, but interconnected, estuarine systems, which extend 155 miles from Ponce Inlet to Jupiter Inlet on Florida's east coast. The northern portion of the lagoon is within the St. Johns River Water Management District. The estuary is characterized by the greatest species diversity of any estuary in North America, and supports multimillion dollar fishing, clamming, tourism, agricultural, and recreational industries. The drainage basins for the lagoon have been substantially modified by human activity. The combined effects of storm water runoff, drainage, navigation, and agricultural and urban development have severely impacted the lagoon’s water, sediment, and habitat quality.

Resources

Environmental resources of regional significance within the UEC include Indian River Lagoon, Savannas State Preserve, Jonathan Dickinson State Park, the St. Lucie River, Pal-Mar, DuPuis Reserve, and the northern Savannas.

Specific Watershed Goals

The management goals for the Indian River Lagoon and St. Lucie Estuary are to attain and maintain water and sediment quality to achieve a healthy, macrophyte-based, lagoon system which supports endangered and threatened species, fisheries, and recreation (SFWMD and SJRWMD, 1994).

Status of Areas of Responsibility

The four areas of responsibility are water supply, flood protection and floodplain management, water quality, and natural systems.

Water Supply

The *Upper East Coast Water Supply Plan* (SFWMD, 1998d), approved by the District's Governing Board in 1998, concluded that historically used sources of water, especially the Surficial Aquifer System in the coastal portions of the region, are not sufficient to meet projected water demands during a 1-in-10 year drought condition. However, with appropriate management and diversification of water supply sources, sufficient water is available to meet the needs of the region. Analyses indicated that the traditional source for urban water needs, the surficial aquifer, has limited potential for expansion due to potential impacts on wetland systems, and increased vulnerability to saltwater intrusion in the vicinity of PWS wellfields. In western portions of the region, where surface water from the regional canal system is heavily relied upon for agricultural needs, analysis showed that existing surface water supplies are inadequate to meet existing, as well as future, demands. However, it was concluded that when supplemented with water from the Floridan aquifer, the combination of sources is sufficient to meet the needs of agriculture. In fact, preliminary evaluations indicate that the Floridan aquifer has sufficient supplies to meet both existing and future PWS and agricultural demands.

Flood Protection and Floodplain Management

A regional canal system is located in the western, agricultural areas of St. Lucie County (the C-23, C-24, and C-25 canals), as well as extensively developed secondary canal systems. These systems were constructed for flood control and have limited surface water storage capabilities.

The SFWMD has received numerous complaints of flooding from eastern St. Lucie County. The St. Lucie (C-44) Canal is the only regional canal in Martin County, although half of the C-23 Canal's drainage basin is within Martin County. The St. Lucie Canal was constructed for navigation and as a flood control outlet for Lake Okeechobee. It

receives runoff from numerous secondary systems and it has limited surface water storage capabilities.

Water Quality

The surface water quality in the UEC region is generally rated as good. However, there are major problem areas in Five and Ten Mile creeks near Port St. Lucie. These creeks receive runoff from agricultural lands and exhibit high levels of pesticides and herbicides. Also, the St. Lucie River is impacted by runoff from urban development, especially near Manatee Pocket, which has poor water quality. The Savannas, a long freshwater marsh located between Fort Pierce and Stuart, has excellent water quality. The Loxahatchee River has good-to-fair water quality. Problem areas include a small portion of the North Fork of the Loxahatchee River, which has had low dissolved oxygen levels, and waters within Jonathan Dickinson State Park, which have exhibited high coliform counts. Large regulatory releases of fresh water from Lake Okeechobee to the St. Lucie River during times of heavy rainfall adversely impact the health of the estuaries associated with the river.

Water quality within the Surficial Aquifer System meets state drinking water standards, although localized areas of poor water quality do exist. The proximity of the Surficial Aquifer System to the surface in this region increases its susceptibility to contamination. In addition, because of increasing demands being placed on the system, it is in constant threat of saltwater intrusion along the coast. Zones of increasing mineralization tend to occur locally along the coast, due to saltwater intrusion, and inland where residual seawater or Floridan Aquifer System irrigation water have left high total dissolved solids concentrations. This limits withdrawals from PWS wellfields that utilize conventional lime softening as the means of treatment in these areas.

Water in the Floridan Aquifer System is of high mineral content and not suited for potable use without undergoing pretreatment. At this time, the primary utilization of the Floridan system within this region is for irrigation purposes.

Natural Systems

The Indian River Lagoon system has the highest species diversity of any estuary in North America. Approximately 2,200 species have been identified in the lagoon system, with 35 of these species listed as threatened or endangered. Species diversity is generally high in the south end of the lagoon system and near inlets. It is lower near cities, where nutrient input, sedimentation, and turbidity are high, and where large areas of mangroves and seagrasses have been lost.

Since the 1950s, the Indian River Lagoon system has lost over 75 percent of its emergent wetlands through destruction and impoundment. While many impoundments of the high salt marsh and mangrove communities have furnished needed mosquito control, they have also isolated the vast majority of the marsh and mangrove community from the lagoon.

Seagrass beds play an important role in biological productivity and diversity, and are a critical component of the Indian River Lagoon. Some seagrass beds may be threatened by adverse water quality conditions, especially increases in turbidity and nutrients.

Upper East Coast Issues

The major issues affecting the UEC regional watershed are surface water supply availability, undesirable salinity fluctuations and increased nutrient loading, and loss of seagrass beds and other wetlands.

Surface Water Supply Availability

The *Upper East Coast Water Supply Plan* (SFWMD, 1998d) is being implemented locally and the five-year update of the plan will be completed by 2003. The UEC Water Resource Caution Areas will be updated by 2001. The Indian River Lagoon Restoration Feasibility Study will also address this issue.

Undesirable Salinity Fluctuations and Increased Nutrient Loading

A major water quality issue within the Indian River Lagoon stems from extreme, salinity fluctuations, which occur as a consequence of modified freshwater inflows. Large regulatory releases of water from Lake Okeechobee to the St. Lucie River adversely impact the salinity and health of the estuary. After prolonged periods of heavy rainfall, the level in Lake Okeechobee can rise above the maximum regulation schedule, forcing damaging discharges to the St. Lucie River and, ultimately, to the Indian River Lagoon. For example, prolonged high volume releases from Lake Okeechobee are believed responsible for the defoliation of seagrasses, oyster kills, and the lesioned fishes that occurred within the St. Lucie Estuary during 1998. This issue is being addressed by the Indian River Lagoon SWIM Plan update which is discussed below.

Significant reductions of freshwater discharges to the Indian River Lagoon may occur during extended dry periods because of artificially lowered water tables. Reduced water levels can cause the loss of wetlands, which would otherwise serve as natural storage areas. The reduction of flows through coastal structures may also reflect an attempt to conserve water for agricultural and urban uses. In general, changes in the historic volume, distribution, and timing of inflows can adversely affect salinity gradients, nutrient and suspended matter loadings, sedimentation rates, and biotic communities distribution.

Ten Mile Creek Project. The Ten Mile Creek Project encompasses 1,266 acres in St. Lucie County, just south of Ten Mile Creek and west of Florida's Turnpike. The District is developing this water resource project into a regional storm water attenuation reservoir to restore more natural hydroperiods and improve water quality for the St. Lucie Estuary and the Indian River Lagoon. Construction is scheduled to be completed by 2003.

Other Projects. Indian River Lagoon and St. Lucie Estuary monitoring, modeling, and research will continue. This issue is also being addressed by the Indian River Lagoon SWIM Update and the Indian River Lagoon Restoration Feasibility Study which are discussed below. An established MFL for the St. Lucie Estuary is anticipated to be completed by 2001.

Loss of Seagrass Beds and Other Wetlands

The Indian River Lagoon Technical Advisory Committee identified seagrass protection and management, and the loss of emergent wetlands and their isolation from the lagoon, as its dominant concerns. Through the SWIM Habitat Program, the technical advisory committee is trying to define and achieve seagrass management requirements that focus on the preservation of existing seagrass beds and continue to protect and rehabilitate the lagoon's salt marshes.

Rehabilitation of the impounded wetlands could have the greatest, most expedient impact on improving the lagoon ecosystem. Most of the emergent saltwater wetlands have been impounded for mosquito control. Reconnecting the impoundments to the lagoon (through the use of gated culverts or pumping systems) is the primary method of marsh rehabilitation proposed. Indian River Lagoon/St. Lucie Estuary monitoring, modeling, and research continue to address this issue. This issue is also being addressed by the Indian River Lagoon SWIM Plan Update and the Indian River Lagoon Restoration Feasibility Study which are discussed below.

Indian River Lagoon SWIM Plan

The *Indian River Lagoon SWIM Plan* (SFWMD and SJRWMD, 1994) is currently being updated to include an assessment of activities that have been completed or begun since 1994. The update is scheduled for completion in 2001. The purpose of the update is to evaluate the effectiveness of initial strategies; assess the progress made in both research and implementation activities; identify new issues and opportunities facing the Indian River Lagoon and associated water bodies; and develop goals, objectives, strategies, and projects to address these issues. Storm water retrofits, habitat restoration, Pollution Load Reduction Goal (PLRG) development, construction of surface water storage facilities, and appropriate monitoring and research efforts will continue in an ongoing attempt to improve water quality within the Indian River Lagoon watershed.

Indian River Lagoon Restoration Feasibility Study

As a component of the Restudy, the Indian River Lagoon Restoration Feasibility Study was initiated in July 1996. The study is examining water resource issues of the UEC region, focusing on alternative surface water management options in the project canal basins of Martin and St. Lucie counties. The purpose of the study is to investigate making structural and operational modifications to the C&SF Project to improve the quality of the environment, improve protection of the aquifer, improve the integrity, capability, and conservation of urban and agricultural water supplies, and other water-related purposes.

This study is being equally cost-shared with the USACE. It is scheduled for completion in 2002. The stated objectives include the following:

- Improve quality, quantity, timing, and distribution of freshwater flow to estuaries
- Improve habitat quality in estuarine ecosystems
- Improve functional quality of wetland ecosystems
- Eliminate excessive sediment loading to estuaries
- Eliminate flocculent ooze
- Improve regional water supply for urban and agricultural use
- Maintain a healthy estuarine ecosystem which supports recreation and an abundance of commercially and recreationally important fisheries
- Enhance opportunities for ecotourism

Upper East Coast Regional Watershed Strategies

The SFWMD has proposed strategies to address the issues within the UEC regional watershed. These strategies are identified by area of responsibility and core objective, and implemented through budget activities (or projects). Districtwide tasks that cover more than one regional watershed are not discussed within this chapter. Therefore, not all core objectives are discussed within this chapter, even if the projects will benefit the watershed. Districtwide tasks, along with a more complete description of the tasks mentioned below, are presented in **Chapter 3** through **Chapter 6**.

Water Supply

Core Objective WS 1: Increase available water supplies and maximize overall water use efficiency to meet identified existing and future needs

Planning

- Review the UEC Water Resource Caution Areas by 2001
- Revise and complete the five-year update of the Upper East Coast Water Supply Plan by 2003

Public Works Construction

- Complete the construction of the Ten Mile Creek Critical Project by 2003
- Complete construction of the C-23 and C-24 basins water preserve area by 2009
- Continue implementing the recommendations in the *Upper East Coast Water Supply Plan*)

Outreach

- Continue assisting with local implementation of the *Upper East Coast Water Supply Plan*

Core Objective WS 2: Prevent contamination of water supplies

Monitoring and Evaluation

- Develop a scientific basis for wetland protection criteria used in water use and environmental resource permitting by 2003

Water Quality

Core Objective WQ 1: Protect and improve surface water quality

Planning

- Update the *Indian River Lagoon SWIM Plan* by 2001

Monitoring and Evaluation

- Continue Indian River Lagoon and St. Lucie Estuary monitoring, modeling, and research

Flood Protection and Floodplain Management

The District has not developed specific strategies for this area of responsibility for the UEC region, but strategies under Districtwide efforts (**Chapter 4**) include activities that will enhance flood protection and floodplain management in the UEC region.

Natural Systems

Core Objective NS 1: Maintain the integrity and functions of water resources and related natural systems

Planning

- Implement the Indian River Lagoon Restoration Feasibility Study by 2001

Land Acquisition

- Acquire land for the DuPuis Reserve

Regulation

- Develop rules for low-level releases of water from Lake Okeechobee to the St. Lucie Estuary

Monitoring and Evaluation

- Continue monitoring Indian River Lagoon seagrasses

KISSIMMEE BASIN REGIONAL WATERSHED

Overall Kissimmee Basin Regional Watershed

The Kissimmee Basin includes parts of Orange, Osceola, Polk, Highlands, Okeechobee, and Glades counties. The basin is comprised of two watersheds: the Upper Kissimmee and the Okeechobee watersheds. Portions of the Okeechobee Basin are also considered, for planning purposes, to be within the LEC and LWC regions.

The Kissimmee Basin encompasses 3,568 square miles and has an average elevation of 63 feet. Annual average rainfall is 50 inches, falling mainly during the May to October wet season. The region contains numerous lakes and is dominated by the Kissimmee River. Most of the region's expanding population resides in the northern portion of the region (Orange and Osceola counties), south of which agriculture remains the principal land use.

The majority of the region drains to the Kissimmee River, although some areas drain into Fisheating Creek, the canal system within Indian Prairie Basin, or a few landlocked lakes within the region. In its natural state, the Kissimmee River rose out of the Kissimmee Chain of Lakes and slowly made its way through a one to two miles wide floodplain supporting a variety of wildlife habitats. The Kissimmee's broad, yet shallow, overland flow of fresh water once snaked its way southward through a 103-mile course before emptying into Lake Okeechobee.

When channelized to become the C-38 Canal, the river's natural length of 103 miles between Lake Kissimmee and Lake Okeechobee was reduced to 56 miles. Because the total difference in elevation between lakes at the north and south ends of the system is approximately 36 feet, the canal was constructed as a series of five, equally spaced, terraced pools whose water levels are held constant by six water control structures and adjoining locks.

Regional Watershed Goals

The Kissimmee Basin regional watershed goals are as follows:

- Manage the headwaters of the Kissimmee Basin to provide more natural flow conditions to the river while maintaining flood protection within the region
- Restore the ecological integrity of the Kissimmee River and floodplain ecosystem
- Reestablish discharges to the Okeechobee Basin that are necessary to restore the ecological integrity of the Kissimmee River while optimizing environmental improvements to the Upper Kissimmee Basin

- Manage the Chain of Lakes to minimize tussock development and conduct periodic lake drawdowns to remove existing tussocks
- Reduce local flooding

Status of Areas of Responsibility

The four areas of responsibility are water supply, flood protection and floodplain management, water quality, and natural systems. A summary of the status of each area of responsibility within the Kissimmee Basin region is provided below.

Water Supply

The Kissimmee Basin region as a whole is, historically, the least problematic of the four SFWMD regions for water supply purposes. However, population is projected to grow by 89 percent between 1995 and 2020, and increases in irrigated agricultural acreage are anticipated in Highlands, Okeechobee, and Glades counties. Total water supply demand, under average rainfall conditions, is projected to increase by 56 percent between 1995 and 2020 (SFWMD, 1998b).

The primary water source for urban and agricultural use is the Floridan aquifer, due to the limited capacity in the surficial aquifers. Floridan Aquifer System wells produce greater quantities of water and are a reliable source of water during periods of drought. Well yields from the Floridan aquifer in the Kissimmee Basin average about 1,500 gallons per minute (gpm). There is also limited use of lakes for agricultural irrigation and urban use.

Throughout most of the Kissimmee Basin, the surficial aquifer produces good quality water of low mineral content, although it does not yield sufficient quantities of water for many applications. The proximity of the Surficial Aquifer System to the surface in the Kissimmee Basin increases its susceptibility to contamination. Lack of confining layers, high recharge, relatively high permeability, and a high water table in most areas where this unit exists, all increase contamination potential.

Flood Protection and Floodplain Management

The C&SF Project in the region consists of the Kissimmee River (C-38 Canal) and six structures in the lower basin; 14 canals and eight structures between the lakes in the Upper Kissimmee Basin; and the Lake Istokpoga-Indian Prairie water control system, consisting of four canals and eight structures and located northwest of Lake Okeechobee. Additional project works, such as the levees and water control structures, exist along the northern shore of Lake Okeechobee. Minimal secondary flood control facilities exist, other than those that were constructed by developers and subsequently deeded over to local governments for long-term maintenance.

Water Quality

Several water bodies within the region have been designated as priorities for SWIM plans, based on water quality, condition of the wetlands, public use, and wildlife habitat areas. The water bodies within the Upper Kissimmee Basin which have been designated as priorities for SWIM plans include the Kissimmee Chain of Lakes and the Alligator Chain of Lakes. Several water bodies within the Okeechobee Basin have also been designated as priorities for SWIM plans: Lakes Okeechobee, Weohyakapka, Arbuckle, Butler, and Istokpoga. Of these, Lake Okeechobee has an adopted SWIM Plan and a water management plan is presently being developed for the Kissimmee Chain of Lakes.

Natural Systems

The channelization of the Kissimmee River in the 1960s altered the hydrology and physical form of the Okeechobee Basin, and caused the loss of many of the environmental values of its original ecosystem. Over 40,000 acres of floodplain wetlands disappeared and the alterations degraded fish, wading bird, waterfowl, and other wildlife habitat. Degradation of the natural cleansing capabilities of the river's historic oxbow and floodplain marshes, coupled with major changes in land use during the 1960s and 1970s, also increased phosphorus loading into Lake Okeechobee.

Upper Kissimmee Basin

Resources

The significant natural system resources within the Upper Kissimmee Basin are the Kissimmee River, the Kissimmee Chain of Lakes, the Alligator Chain of Lakes, the Three Lakes WMA, Walker Ranch (Disney Preserve), the Lake Forest Preserve, Reedy Creek, and Marian Creek.

Upper Kissimmee Basin Issues

The major issues affecting the Upper Kissimmee Basin are water supply availability, Chain of Lakes maintenance and water quality problems, and overall basin water quality.

Upper Kissimmee Basin Water Supply Availability

The *Kissimmee Basin Water Supply Plan* (SFWMD, 2000a) has been completed. An ongoing analysis of water supply issues in the Orlando Metropolitan Area by the St. Johns River Water Management District indicates that over the long-term, the existing ground water resources will have to be supplemented by additional wells from outside the metropolitan area or by surface water withdrawals, primarily from Lake Monroe. Additionally, the Southwest Florida Water Management District has identified several lakes on top of the Lake Wales Ridge whose water levels have decreased in the recent

past, probably due to ground water withdrawals to the west. The SFWMD continues to work with both districts to ensure a comprehensive approach to the management of both ground and surface water resources in Central Florida. Ground water contamination from drain wells is a potential issue of concern in Orange and Osceola counties.

Chain of Lakes Maintenance and Water Quality Problems

Water level is a key environmental issue affecting the lakes in the Upper Kissimmee Basin. These lakes, called the Kissimmee Chain of Lakes, suffer long standing problems of stage stabilization and overall reduction in stage from historical levels. Although the lakes continue to support a generally excellent fishery, the range of water fluctuation, which is critical to the long-term health of the littoral zone, affects fish population and wading birds. The problems associated with level stabilization have been offset, to some degree, for several of the major lakes by new management procedures and drawdowns carried out over the past decades.

Changes in the management of the water levels in the lakes in the Upper Kissimmee Basin will be made possible by the completion of the downstream Kissimmee River restoration activity. These management changes will enable the lakes to attain better ecological health. However, drawdowns and removal of sediments from the lakes will continue to be necessary, hopefully at longer time intervals. This is an ongoing project for the drawdown and maintenance of the Alligator Chain of Lakes for 1999 through 2002.

Upper Kissimmee Basin Water Quality Problems

The most notable water quality problem area in the Upper Kissimmee Basin occurs in Lake Tohopekaliga. Lake Tohopekaliga has demonstrated signs of eutrophication as a result of high nutrient loading from wastewater plant discharges and nonpoint source runoff. Stopping the practice of discharging wastewater into the lake has reduced phosphorus loading and resulted in improved water quality. Aquatic weeds continue to be a problem in Lake Tohopekaliga, as well as other lakes in the Kissimmee Basin, including Lakes Cypress, Hatchineha, and Kissimmee. Water clarity is the major problem associated with Lake Istokpoga, but turbid water may be a naturally occurring condition.

Lakes in the Upper Kissimmee are frequently the receiving water bodies of storm water runoff from the rapidly developing Orlando Metropolitan Area. As development continues past the Orange County border and into northern Osceola County, the potential for water quality degradation of the lakes increases. Continued protection of the remaining wetlands, along with continued monitoring and improved storm water quality practices will become necessary.

Okeechobee Basin

Resources

The significant natural system resources within the Okeechobee watershed include the Kissimmee River; Lakes Okeechobee, Weohyakapka, Arbuckle, Butler, and Istokpoga; the Avon Park Bombing Range; the Audubon Sanctuary; Fisheating Creek; and Nicodemus Slough.

Okeechobee Basin Issues

The major issues affecting the Okeechobee Basin are water supply availability, continuation of the Kissimmee River Restoration Project, and impacts to Lake Okeechobee water quality.

Okeechobee Basin Water Supply Availability

Historically, the Lake Istokpoga-Indian Prairie Basin, located in the southwestern portion of the region, has had water shortages. Water use in the basin is primarily agricultural. The Floridan aquifer is intensively used, but water quality is variable. Because of its limited contributing area, surface supplies in this basin are limited. The District is developing a Lake Istokpoga Regulation Schedule by 2002.

Continuation of the Kissimmee River Restoration

Degradation of the Kissimmee River's water quality, wetlands, and ecosystem has been the subject of numerous local, state, and federal studies. The SFWMD is currently engaged in an effort to reintroduce flows to remnant river oxbows and restore 26,000 acres of wetlands in the river floodplain. Backfilling of 1,000 feet of the canal was started in 1994 to test construction methods and provide information to aid in the remaining work. This preparatory work has been completed and work on the actual restoration has begun. The remaining land acquisitions, engineering, and construction activities necessary to complete the restoration is scheduled to be implemented by 2011, but completion is contingent upon continued federal funding. Kissimmee River restoration research and evaluation data will be published by 2011 and coordination of flood restoration efforts involved with the project will continue.

Impacts to Lake Okeechobee Water Quality

Agricultural runoff flowing too quickly into the Kissimmee River system results in nutrient enriched waters within Lake Okeechobee. Large algal blooms in the 1970s and 1980s suggested that Lake Okeechobee was receiving excessive nutrients and becoming increasingly eutrophic. Both phosphorus and nitrogen contribute to algal growth, but bacteria and blue-green algae can fix nitrogen from the atmosphere and add it to the water column making nitrogen harder to control than phosphorus. Accordingly, the primary water quality issue associated with the lake is the control of phosphorus.

Historically, one source of phosphorus and other nutrients entering Lake Okeechobee has been the tributaries within the Lower Kissimmee Basin, including Taylor Creek. Taylor Creek has had some of the poorest water quality in the state, with frequent violations of dissolved oxygen standards, as well as elevated bacteria and nutrient levels. These problems were associated with runoff from dairy farms in the area. The Florida Department of Agriculture and Consumer Services Dairy Buy-Out Program, in conjunction with the FDEP's Dairy Rule (Chapter 62-670, F.A.C.), has worked to address these problems.

Lake Istokpoga-Indian Prairie Area

In the Lake Istokpoga-Indian Prairie area, periodic water shortages and design deficiencies of the major water control structures are the major issues of concern and are now being addressed. An investigation of the Lake Istokpoga regulation schedule is targeted for 2002. A mobile irrigation lab, utility audit project, and conservation plans are scheduled for 2003. A wetlands impact study and Lake Istokpoga pump installation are scheduled for 2004.

Kissimmee Basin Regional Watershed Strategies

The SFWMD has proposed strategies to address the issues within the Kissimmee Basin regional watershed. These strategies are identified by area of responsibility and core objective, and implemented through budget activities (or projects). Districtwide tasks that cover more than one regional watershed are not discussed within this chapter. Therefore, not all core objectives are discussed within this chapter, even if the projects will benefit the watershed. Districtwide tasks, along with a more complete description of the tasks mentioned below, are presented in **Chapter 3** through **Chapter 6**.

Water Supply

Core Objective WS 1: Increase available water supplies and maximize overall water use efficiency to meet identified existing and future needs

Planning

- Complete the development of the *Kissimmee Basin Water Supply Plan* during 2000

Public Works Construction

- Implement the water resource development projects recommended in the *Kissimmee Basin Water Supply Plan*

Operations and Maintenance

- Develop Lake Istokpoga Regulation Schedule by 2002

Flood Protection and Floodplain Management

Core Objective FP 1: Minimize damage from flooding

Public Works Construction

- Construct facilities for the flood mitigation efforts associated with the implementation of the Kissimmee River Restoration Project

Monitoring and Evaluation

- Continue the analyses of the flood control level of service for the Kissimmee Basin

Water Quality

Core Objective WQ 1: Protect and improve surface water quality

Planning

- Develop a SWIM plan for the Kissimmee Chain of Lakes by 2001

Public Works Construction

- Construct the Taylor Creek/Nubbin Slough Reservoir and STA by 2009

Monitoring and Evaluation

- Collect and evaluate data to assess sources of phosphorus from the Upper Kissimmee Chain of Lakes and to assess if the TMDL and MFL requirements can be met

Natural Systems

Core Objective NS 1: Maintain the integrity and functions of water resources and related natural systems

Planning

- Develop MFLs for the Kissimmee Basin by 2006

Land Acquisition

- Continue to provide for the acquisition, restoration, and management of the Kissimmee Mitigation Project
- Continue to provide for the acquisition, restoration, and management of the Shingle Creek Mitigation Project
- Continue to provide for the acquisition, restoration, and management of the Upper Lakes Basin Mitigation Project

Core Objective NS 2: Restore degraded water resource and related natural systems to a naturally functioning condition

Land Acquisition

- Acquire 12 to 15 ownerships for the Kissimmee River Restoration Project by 2011

Public Works Construction

- With the USACE, design and construct Kissimmee River restoration components by 2011 to meet restoration goals
- Continue ongoing engineering for meeting flood protection constraints and ecosystem goals for Kissimmee River Restoration Project

Monitoring and Evaluation

- Publish Kissimmee River restoration research and evaluation data by 2011
- Continue hydrologic monitoring to support the Kissimmee River Restoration Project